DOCUMENT RESUME

ED 180 845 SE 029 949

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TITLE Student's Choice--Self-Pacing And/Or the Lecture Method for Introductory Statistics.
PUB DATE 79
NOTE 9p.: Contains occasional broken type

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *College Mathematics: Computer Oriented Programs: *Course Evaluation: Higher Education: Homework: Independent Study: Lecture: Mathematics Curriculum: *Mathematics Instruction: *Program Descriptions: Programed Instruction: Research: *Statistics: Testing
IDENTIFIERS *Brigham Young University UT

ABSTRACT

In the early 1970's, a major modification of the introductory service course in statistics at Brigham Young University was implemented, first on an experimental basis and then in all sections by 1974-75. The basic components of the course that distinguish it are: a self-pacing text prepared under the guidance of educational research specialists: a choice of self-pacing or standard lecture format for students: testing outside the classroom in the University's Testing Center with immediate test feedback and opportunity for test rechallenges: access to graduate student help on tests and homework in a test feedback and homework center: and optional, extra-credit work on the computer, computer projects, and outside readings. Unsolicited student comment has been very favorable toward the course. In addition, responses from a series of questionnaires administered to students taking the course indicate that objectives were being met. (Author/MK)

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STUDENT'S CHOICE -- SELF-PACING AND/OR THE LECTURE METHOD FOR INTRODUCTORY STATISTICS

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ABSTRACT

In the early 70's, a major modification of the introductory service course in statistics at Brigham Young University was implemented, first on an experimental basis, and in all sections by 1974-75. The basic components of the course that distinguish it are: a self-pacing text prepared under the guidance of educational research specialists, a choice of a self-pacing or standard lecture format for students; testing outside the classroom in the University's Testing Center with immediate test feedback and opportunity for test rechallenge; access to graduate student help on tests and homework in a test feedback center and homework center; and optional, extra-credit work on the computer, computer projects, and outside readings. Unsolicited student comment has been very favorable toward the course. In addition, responses from a series of questionnaires administered to students taking the course indicate that we are meeting our objectives.

INTRODUCTION

When an introductory statistics course is discussed among a group of instructors, one or both of two types of courses may be implied. One type of introductory course might be the so-called "statistics appreciation" course, a course whose main objective is not to present statistical methods as such, but is intended to present the non-mathematical student with some underlying statistical concepts. Typical of these topics are concepts of proper experimental design, concepts and procedures of probability sampling, the effect of variability, the purpose of randomness, some basic descriptive procedures, etc. These courses assume very little or no math, with computations no more complex than that of computing a mean. Several texts in this area are: Statistics by Freedman, Pisani and Purvis; Statistics, A New Approach by Wallis and Roberts; Statistics, Concepts and Controversies by Moore, etc. The Statistics: A Guide to the Unknown series represents a good set of companion volumes for such a course.

The other type of introductory course is the more traditional course whose topics might be chosen from the techniques of descriptive statistics, probability, sampling distributions, confidence intervals, t-tests, χ^2 tests for contingency tables, linear regression, introduction to analysis of variance, and so forth. This type of course requires more mathematical background with the texts by Huntsberger, Freund, Mendenhall, and others being typical texts for such a course.

At Brigham Young University we have both types of courses. In both cases they are primarily service courses to other departments in the university community. The topic of this paper deals with a description of our approach to the latter, more traditional introductory course in statistical methods.

HISTORICAL BACKGROUND

From the time the Department of Statistics was formed in the early 60's up through about 1972, our course was taught by the lecture method in sections of about 30-40 students each. The clientele for this course came mainly from the College of Business. However, more and more departments were requiring their students to take

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a basic statistics course and thus the total number of students we served showed a steady increase over that time span. To handle this increase in enrollment, we ended up assigning more and more of our sections to be taught by graduate students, many of whom proved extremely capable in this assignment. However, we had several concerns that finally brought us to a change of direction in our approach to the course. First, we were concerned about the consistency of topics covered and the quality of presentation from section to section as more and more sections were taught by more and more different individuals. Secondly, this course represented an important source of undergraduate majors, and we felt that the source was in danger as fewer of the courses were taught by full-time statistics faculty who could do some recruiting. Thirdly, we had long been aware of student disenchantment for the course in terms of its relevance to specialized areas or majors; we were also aware that we were developing a reputation of having one of the more difficult courses in a student's curriculum. In fact, evidence tended to indicate students were putting off a Sophomore-level course until their Junior or Senior years, and then taking the course with a certain amount of fear and worry.

Through a variety of actions taken in 1972, a working arrangement was set up between the Department of Statistics and the Department of Instructional Development (DID) now a part of the David O. McKay Institute of Education. The objective of this cooperative effort was to develop instructional strategies intended to correct the three concerns we had as a department.

A preliminary study was undertaken to validate or invalidate our preconceived ideas about student reaction to the course. The study identified seven problem areas (Green and Christensen 1977):

1. Other departments had not felt that the Statistics Department was making its elementary statistics course relevant to the peculiar problems commonly met by majors in sociology, psychology, education, physical education or business.
2. Practical application of most statistical concepts was not apparent to the students, causing them to be bored and negative about the course.
3. The reputation of the course was such that the students delayed taking it until their junior and senior years, although it was orginally conceived as a sophomore-level course.
4. So many different instructors were teaching the course that great variability existed among the sections of the course being taught.
5. Many lecture sections were not being taught by full-time faculty members, but by inexperienced graduate assistants.
6. Lab space was inadequate.
7. The lab manual was not coordinated with problems in the lecture, the text, or the examinations.

To address these seven problem areas a senior author from the Department of Statistics was assigned to work with the personnel from DID to develop course materials, examples, tests, etc. to fit into a framework designed by DID to improve our course.

One of the first steps was to meet with representatives of all other departments who had students taking an introductory statistics course. Our purpose was to define what topics they expected their students to get from an introductory course. Compromise was an essential ingredient in these meetings, but out of it came a course description that all participants recognized as practical under the circumstances.

The next step was to develop, under direction and guidance of DID, mappings that showed the interrelationships of concepts associated with the course description defined by the interdepartmental committee. This was no easy exercise and a great deal of effort went into it.

At the conclusion of this phase, DID took the information generated and proposed a strategy for teaching the course. (Up to this point there had been no prior assumption made as to the media that would be used for instruction--films, slides, tapes, books, etc. were all possibilities--the final form had intentionally been left undefined so that as few constraints as possible were imposed in the earlier, developmental stages.)

The proposal from DID was to prepare a textbook using concepts they had developed for use on a computer assisted instructional program called the TICCIT project. This textbook was to be self-pacing but was not a programmed text. In addition, a large section format was proposed with an instructional management system devised to monitor the student's progress through the course.

This system was implemented on an experimental basis the Fall of 1973. It was implemented on a full scale in the Fall of 1975 and has continued to the present with both major and minor revisions over that time span. The basic components of that system will be discussed in the following sections.

INSTRUCTIONAL MATERIAL

The Textbook:

The textbook (Christensen, 1977) consists of Units (chapters) and Lessons within Units. Each Unit consists of a broad class of related concepts, e.g. one units covers graphical methods, another covers confidence intervals. A given lesson in a unit covers a single concept or a small group of closely related concepts. For example, one lesson in the Unit on confidence intervals covers the concept of unbiased and efficient estimators, another the concept of a standard error, still another lesson covers the concept of a confidence interval for a single mean, etc. The distinctive feature which makes the text different from other texts is the consistency of format from lesson to lesson.

Each lesson is made up of the following parts:

1. The Task Statement: A statement is made of the skill or concept to be learned and applied in the lesson.
2. The Definition: A concise definition of the concept or concepts is given in a short definition section.
3. The Discussion Section: This is an elaboration on the definition(s) with simple examples to put the definitions in a framework that the background experiences of the student would help him/her to understand better. Interrelationships of concepts would be pointed out.
4. The Simplified Discussion (Optional): In those situations where the experiences of the author indicated the concepts under discussion were particularly difficult to grasp by the student, an extra, simpler discussion using analogies and detailed examples was included.
5. Example Problems: Examples with detailed explanations are given to place the concept in concrete terms for application.
6. Practice Problems: Problems similar to the example problems are given to allow the students to test his/her skills. Answers to the odd-numbered practice problems are available to the student at the end of each Unit and the even numbered answers are in the teachers supplement.

Each lesson is set up using the same format which makes it possible for the student to work more efficiently through the materials as well as allowing him/her to develop a more personalized study strategy as familiarity with format and material increases. For example, one student may find that the definition and example problems are sufficient to understand the concept. Another might choose to go to example problems first and then back to definitions and then to practice problems.

To unify the lessons, they are grouped together in a logical manner, each unit containing a:

1. Unit Map which serves the purpose of showing graphically a logical "series" or "parallel" connection to the individual lessons in the Unit.
2. Introduction and Vocabulary section to point the direction the unit takes as well as identifying the new terms to be covered in the Unit.
3. Lesson Series, the basic pedoyogical component in the Unit.
4. Application Section to describe how the material in the unit relates to real world settings as well as its connection to preceding and succeeding Units.
5. Summary Section to pull together in a capsulization, the various concepts presented in the Unit.
6. Unit Self-Test, a test that prepares the student to take a format test on the material--answers are provided at the back of the textbook.
7. Answers to Practice Problems, to provide immediate feedback to students on their mastery of the concepts and skills in each of the lessons.

The interrelationship of all these components are shown in Figure 1 that follows.

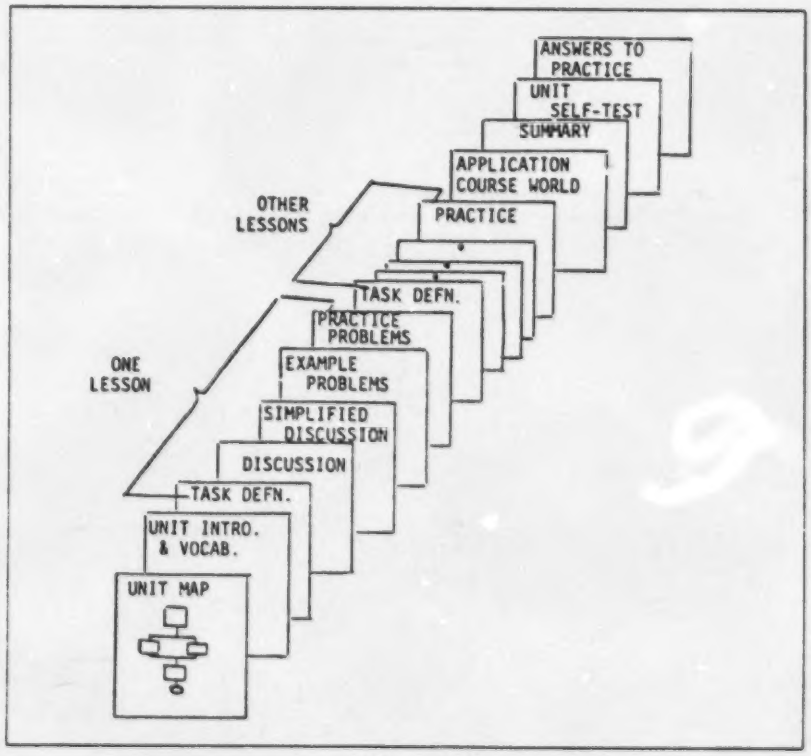

Figure 1.

MANAGEMENT SYSTEM

Lectures

At the beginning of the course the student is told that the course is set up for self-study and self-pacing (within certain time guidelines); but for those students desiring the security of a regular lecture format, a regular lecture session would be available. To accomodate the approximately 600 students enrolled each semester, four lecture sections are provided and a detailed daily lecture schedule is laid out for the student. These sections are taught by full-time faculty who have special interests in teaching.

Testing Center

Brigham Young University has a facility that is not standard on all university campuses. Some years ago a testing center was established independent of any of the various academic departments and colleges on campus. The center not only administers the typical national competency and aptitude tests for students but it also serves as a testing center for any department on campus which desires to make use of its services. It has seating to accomodate around 325 students at a time. It is open 8-12 hours a day and on Saturdays. This provides students the flexibility to schedule their own time for taking tests. In-class time isn't used for testing and can be used for instruction. Monitors are trained to oversee the testing operation and are always present.

Their operation has been computerized so that for an objective-type test, the student can receive immediate feedback (within seconds) on the exam indicating which questions were missed, what answers they chose on the missed questions, and even the correct answer if desired. We use this facility in the following manner.

For each test topic we have created 4 parallel exams. We have divided the course so that we have 8 test topics plus a comprehensive final. A student must challenge each test topic but may rechallange each test one additional time at their own expense to improve their grade. The computer keeps track of which exam is challenged and ensures that a different parallel exam is taken on the rechallenge.

In addition to the immediate feedback the student receives, our department receives a weekly alphabetical listing of all students and their scores on all exams up to that point in time. Thus, a regular monitoring is possible for all students, and those having problems can be quickly identified.

To maintain some structure in a system that easily lends to procrastinating, a series of deadlines is set by which each exam must be taken in order for the score to count in the students total. Other than this restriction, a student can go at his own pace, being able to work around other, less flexible courses in his schedule.

Test Feedback

One of the most useful teaching devices is a good review of the test that has been taken and failed by the student. In light of this observation we provide a test feedback center. Here a student may leisurely examine a copy of the exam he took, and consult with a graduate teaching assistant concerning the how's and why's of his incorrect answers. This area is also closely monitored to protect the confidentiality of the exams.

Homework Centers

We provide a study room manned by teaching assistants practically eight hours per day, five days per week plus several evening hours. Here students can study and receive help on questions they encounter in their regular reading and problem solving. Test questions cannot be discussed here, but help is given on practice problems found in the text.

Media Helps

Our university library houses a collection of professionally marketed audio cassettes and filmstrips on all topics with several series in statistics. Equipment is available so students may go and view these materials on an individual basis as needs arise.

Instructor

Each instructor reserves office hour time to consult one-on-one with students who desire such consultations.

Extra Credit Options

Students are encouraged to read pertinent articles from the Statistics: A Guide to Unkown series. Encouragement comes by providing extra credit points for such involvement. Also students are encouraged to do a project paper involving data collection, summarization, and analysis. This is written up, typed and submitted for grading. We also provide the opportunity on an extra credit basis for students to work on a time-sharing computer system using Minitab. It is felt that all these options provide extra insight to justify the extra credit given for them.

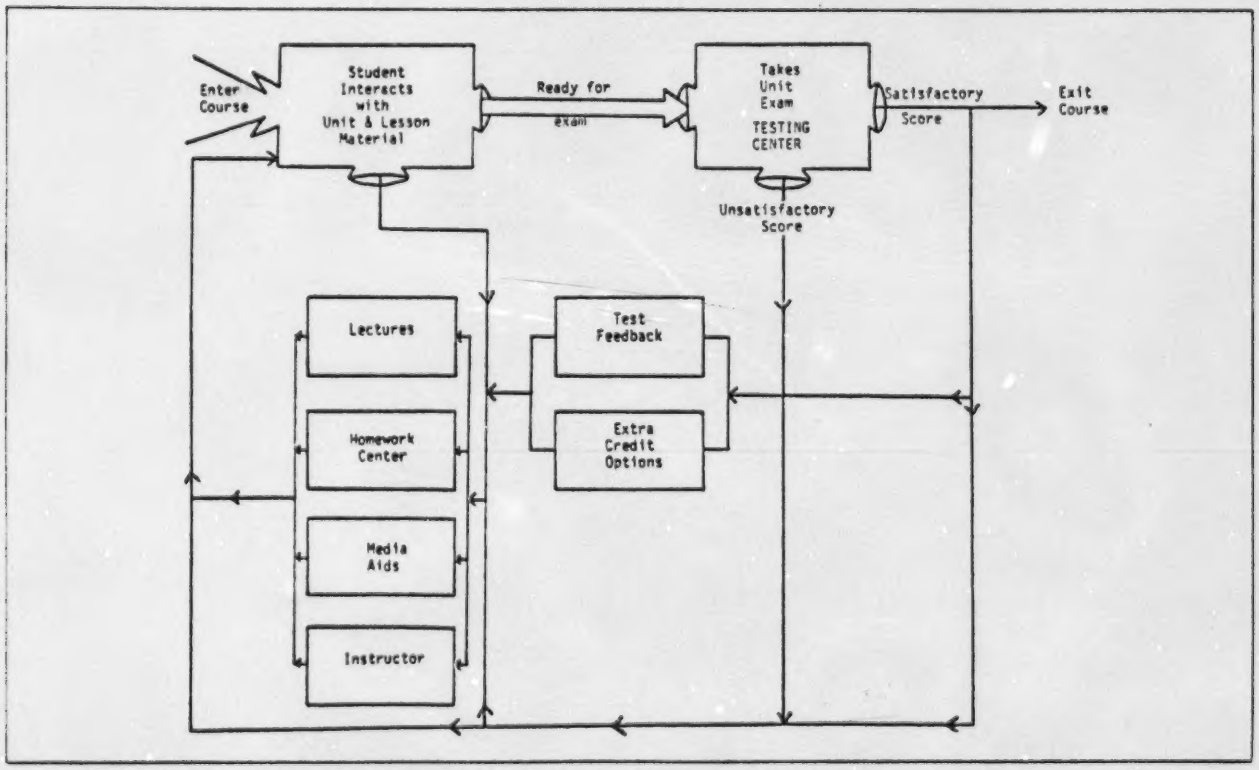

Figure 2. *Instruction and Management System*

All of these components work together as diagrammed in Figure 2 to move the student through a successful experience in what is usually a first and only encounter with a formal statistics course. Subjective feelings from unsolicited student comment has been positive and reassuring concerning the textbook and the operation of the course. More objective feedback is reported in the next section

EVALUATING THE COURSE

Because of the problems of constructing a good experimental design in an ongoing program serving 600 or so students each semester, we do not have the kind of data that would allow us to compare our current operation with our previous operation of the course.

On an on-going basis, the only available information to make comparisons and evaluations is grade distributions. To remedy this situation to some extent, the last few years a series of questionnaires have been administered in the course in order to get descriptive information and opinions about the course.

Summarizing some of this information, a comparison of the grade distributions between Winter Semester, 1973 and Winter Semester 1979 shows a shift in grades towards the A grade although there is hardly any difference in the two years in the total percent of A, B and C's given. This grade shift was anticipated because of allowing tests to be rechallenged. The percent of students receiving D, E, and UW (unofficial withdrawl) grades is not appreciably different for the two years compared. (One concern we had was that the percent of UW's would increase due to the flexibility of the program and the tendency of students to get behind. The data doesn't support this concern with the percent of UW's being the same in the two year comparison.)

The questionnaire data show a minor tendency for more freshmen and sophomores to be registering for the course, though a statistical test declared the change to be non-significiant. About 52-54% of the students declared themselves as attending the lectures frequently or almost always. We infer that more than 40% of the students completing the course are doing it mainly on their own. In addition, the data showed no association between attendance at the lecture and student GPA. There are still questions here that merit further investigation, however.

When asked to rate the text on how well it helped them prepare for the exams about 70% rated it high to very high, about 20% medium and the remaining 10% rated it low to very low. When asked their agreement with the statement that the text presented the material in a clear and concise manner, 82% agreed, 18% were neutral, and 5% disagreed.

For the statement, "the graded tests effectively measured my knowledge," 48% agreed, 27% were neutral and 25% disagreed. Some additional improvement could be made here, though personal experience suggests that students are critical of most tests.

For the statement, "I feel I am receiving a sufficient amount of individual help in the course," 42% agreed, 13% disagreed, and 45% were neutral or unable to judge. This would indicate a lot of students are either not taking advantage of the helps offered or our help is deficient.

Students were asked at the end of the semester to classify their interest in statistics before taking the course and then to indicate their present interest. Fifty-one percent classified their present interest in statistics as "interested" or "highly interested." When looking at the two questions together a shifting of interest before and after the course was observed. Overall, 38% showed an increase in interest while 21% showed a decline in interest.

When asked what rating they would give the course to other students, 38% gave it a "high" to "very high" rating, 41% a "medium" rating and 20% a "low" to "very low" rating. However, when the "interest in statistics" variable is brought into the picture, it was found that of the 51% of the student who expressed interest in statistics, 66% of them gave the course a "high" to "very high" rating.

Several other "affective" questions were asked of students taking their last exam. On a seven-point useless-to-useful scale, 83% regarded statistics as useful in applied research, and 73% felt it to be useful in their own field. In addition, 69% expressed confidence in their ability to understand an introductory statistics text.

Admittedly, the above percentages are quite meaningless without something with which to compare them. However, in most cases they lean toward the positive side of 50% which we interpret as good signs in the absence of comparative data. We also now have a baseline to which we can compare as other innovations and changes are implemented in our programs.

Relative to the seven problem areas identified before our program was implemented, and listed earlier in this paper, the following progress can be noted:

1. Current student reaction seems to indicate that students see a relevance of statistics to their major field, 73% agreeing with that conclusion.
2. We feel we are seeing more interest expressed in the course, but we are still looking at ways to improve our course in regard to this.
3. There aren't any strong signs that a major shift is taking place that would indicate more sophomores are taking this "sophomore level" class. There are some minor signs and time will tell.
4. We have at most 4 to 5 different instructors teaching our 600+ students each semester and in some cases only 2 or 3, compared to 10-15 under the old program.
5. All instructors are full-time faculty or graduate students carefully selected because of outstanding teaching skills.
6. With the testing center available, we have adequate lab space.
7. The lab manual has been done away with and the lecture, text and examinations have become highly correlated.

We have areas in which to improve and we continue to work in these areas, but we feel we have made some significant progress by revising our introductory course as we have. Suggestions and criticisms from all sources are welcome.

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